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[Sur la Presence de Residus d'Hydrocarbures dans les Eaux Ivoiriennes]

ORSTOM, August 1970

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HYDROCARBON RESIDUES IN IVORY COAST WATERS

Summary. For some years, the beaches of Ivory Coast have become more and more polluted by hydrocarbon residues. In addition, plankton net hauls have shown that the quantities of hydrocarbons in suspension in sea water are far from being negligible and generally more important in shallow water near the coast. The presence of oil in the stomachs of pelagic fish and the scarcity of eggs and larvae of these fish suggest the hypothesis that the decrease in the yield of these fish in Ivory Coast waters may at least partially be due to this oil. The authors suggest that strong action should be taken in order to force oil tankers to respect international rules concerning tank cleaning (at a minimum distance of 100 miles offshore) until better cleaning methods are employed.

Globs of "tar" have been seen on some of the beaches along the Ivory Coast littoral since the end of 1967. The phenomenon has become more commonplace over these last months, with all beaches more or less polluted.

One is led to suppose that the entire African littoral, like that of Europe, has little by little been invaded by oil tanker discharge products. There would appear to be no other reason. Observations in Sierra Leone and Dahomey have found the beaches clean, or only very fleetingly dirty (Tema, Ghana; Freetown, Sierra Leone).

These globs of "tar" are almost certainly the result of the degassing of tankers whose routes are in the vicinity of the Ivory Coast.

It is a known fact that since the closing of the Suez Canal in June 1967, tankers coming from the Persian Gulf round the Cape of Good

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Hope en route to Dakar before continuing on to Europe. The empty tankers, on their return voyages, sail at least 100 miles off the African coasts until off Sierra Leone. At a point slightly to the west of Cap des Palmes they cross the 100 mile limit, the limit beyond which they are authorized to degas their tanks. The residues of these cleanings have a gravity less than, or equal to 0.97, and, under the influence of the winds from the southwest sector and the Guinea Current, would appear to settle primarily on the beaches of the Ivory Coast.

Still, these vessels run the risk of running into foul weather when rounding the Cape, something they do not do in the light ship condition. So it is quite likely that they degas when they leave the West African coasts, which would force them to reballast with sea water immediately.

Moreover, there is a great deal of traffic between Europe and Port Harcourt, Riviere Torcados, or Port Gentil, since the Nigerian and Gabonese wells have begun to produce. The tankers coming from Europe skirt the coast at less than 100 miles, loaded to ride the foul weather created by the trades. The risk of foul weather is virtually nil once past Cap des Palmes. The tankers are only a few days from their loading port and sail on this side of the 100 mile curve. Thus, conditions are set so that degassing takes place off the shores of the Ivory Coast. As a matter of fact there has been one direct observation made by French tuna boats. One tanker was surrounded by a hydrocarbon film off Sassandra, a port 120 miles to the west of Abidjan.

This second source of pollution could be more important than the first. It would only be a secondary cause so far as pumping ballast by

merchant ships en route to fuel is concerned. So, why is it that Ivory Coast beaches are practically the only ones attacked?

Although it is not beyond the realm of possibility that some of these residues increase in gravity because of oxidation when they reach the air, or because of bacterial degradation, most of the residues remain on the surface. In the course of the monthly hydrology and planktonology voyages organized by the Projet de Developpement de la Peche Pelagique Cotiere (the PNUD/FAO Project) the participants became aware of the fact that during each voyage a great many of the hauls of the I.C.I.T.A. plankton net brought up tar particles, the sizes of which varied from 1 mm to 1 cm. Some of these nodules have been analyzed. The C/H report proves that they consist of 90% unsaturated petroleum products, with the rest made up of miscellaneous sediments. The gravity of 0.9364 suggests a heavy fuel. And the sulfur content (1.5%) eliminates the Persian Gulf as the origin of the products examined, while at the same time tending to prove that they come from Nigeria.

These voyages began in July 1969, and have covered the continental shelf and the offshore waters from Cap des Trois Pointes to Cap des Palmes on a grid consisting of 12 North-South radials. Each radial included 3 stations on the shelf, and 2 or 3 radials were extended 30 miles beyond the continental slope. Some forty samples were taken each month.

During the second voyage (in August, in mid-winter) these residues were found at the very ends of the longest radials. Then, when the upwellings ceased, and the drift of the surface waters was off shore, the neritic waters seemed more polluted than the offshore waters.

Systematic attention to this question began in April 1970.

The volume of such residues, while quite small (less than 0.5 ml/haul), was calculated in terms of the diameter of the particles, assuming them to be spherical. In other cases the measurements were in terms of displacement in water.

All hauls of the plankton net were made from the bottom to the surface. However, because the particles have positive buoyancy they could not reasonably be expected to be picked up when on the surface. It was, therefore, necessary to calculate their concentration for the surface layer (0 to 1 m), and, in order to give consideration to their importance to the marine economy, to calculate this concentration for the whole of the column of water as well.[1]

Of equal interest is an understanding of the relative importance of petroleum products to plankton. The particle volume has been calculated as a percentage of the volume of zooplankton precipitated.

The following observations were made during the most recent voyages:

(1) during the PK 09 voyage (3-11 April), one of six hauls was contaminated, but the ratio was 1/3 between Abidjan and Cap des Palmes;

(2) between 13-15 May, along a North-South Grand-Bassam radial, some 70 miles off the coast (LT 9), 3 of 10 oblique hauls made contained hydrocarbon particles. The most contaminated station was in depths of 15 m (less than 1/4 of a mile off the coast). Traces were found on two other stations on the shelf, but not beyond;

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[1] It should be remembered that the I.C.I.T.A. net was not designed for studying the neuston, because, in principle, it functions completely submerged. The surface zone thus has been very poorly samples, and all measurements are subject to error by default.

(3) during the PK 10 voyage (29 May-5 June) 1/5 of the plankton hauls was polluted by tanker waste products.

VOLUME OF PETROLEUM PRODUCTS IN THE HAULS
(expressed in number of hauls)

ml hydrocarbons/ 100 m3 water	PK 09		PK 10	
	surface to bottom	surface layer (0-1 m)	surface to bottom	surface layer (0-1 m)
10^{-4}				
10^{-3}	4			
10^{-2}	2	3		
10^{-1}		3	2	
1	1		7	4
10	1	1		5
10^{2}		1		

RATIO OF PETROLEUM WASTE PRODUCTS TO ZOOPLANKTON, IN %
(expressed in number of hauls)

(Volume hydrocarbons/ volume zooplankton) x 100	PK 09		PK 10	
	surface to bottom	surface layer (0-1 m)	surface to bottom	surface layer (0-1 m)
10^{-4}				
10^{-3}	3			
10^{-2}	3	4		
10^{-1}		2	2	
1			6	2
10	2	1	1	6
10^{2}		1		1

MAXIMUM OBSERVED VALUES

		Volume of hydrocarbons (ml/100 m^3 water)	(Volume hydrocarbons/ volume zooplankton)x 100
PK 09	Surface to bottom	2.26	2.33
	Surface layer (0-1 m)	9.05	9.0
LT	Surface to bottom	0.55	0.5
	Surface layer (0-1 m)	3.3	3.0
PK 10	Surface to bottom	0.9	1.7
	Surface layer (0-1 m)	5.5	10.4

The importance of the petroleum products to zooplankton ratio thus is very important in certain cases, and one therefore can expect that it is the plankton-eating fish that absorb these wastes.

Sardinella stomachs were examined for this purpose. The presence of small globs of "tar" was recognized on the basis of the following criteria:

positive buoyancy of the particles;

brownish trace on a glass slide;

dissolve immediately in toluene, leaving brown rings on the slide.

Some of the stomachs in the 15 April 1970, sample contained several particles 2 mm in diameter. In the other cases there were only a few particles and they were the size of a small copepod.

It will be noted that the Ivory Coast samples are practically the only ones contaminated. The absence of residues in the 14 July lot perhaps is due to the drift of the surface waters to sea under the influence of the upwelling that occurred and which had, perhaps, permitted the return of the Sardinella to the Ivory Coast waters they had deserted during these last months.

RESULTS OF EXAMINATION OF STOMACH CONTENTS

Species	S. eba	S.aurita	S. eba	S. eba	S.aurita	S. eba
Origin of lot	"3 villages" (Ivory Coast) 4°10'W	"3 villages" 4°10'W	"3 villages" 4°10'W	Freetown (Sierra Leone)	Cap Coast (Ghana) (47 m)	Gd. Bassan (Ivory Coast) 40 m 3°50'W
Date of catch	25 Feb 70	25 Feb 70	15 Apr 70	30 May 70	14 Jun 70	14 Jul 70
No. stomachs examined	5	5	10	5	5	10
No. stomachs contaminated[1]	2+	0	?+	1?	0	1?

[1] + - no question of presence of petroleum residues
? - traces more or less doubtful

The pelagic fish will not meet the same oil pollution conditions, depending on whether they do, or do not, feed near the surface. The situation is more unfavorable for the Sardinella, generally found in shallow depths, and often near the surface (and this is particularly true of the S. eba, the herring), than for the fish living further out to sea, or which feed near the bottom (Brachydeterus auritus).

Indeed, it is reasonable to assume that quantities of "tar" accumulate in the very close-in waters along the coast. These settle on the beaches as the tide ebbs, and most are once again picked up by rising water and thus are very slowly engulfed in the sand.

The total volume of tar, moreover, it only a very imperfect expression of its noxiousness. The dimension, and the number, of granules are almost more important, hence the danger of the use of chemical agents to break up petroleum products. Indeed, the probability of a plankton strainer encountering a granule larger than 1 cm is very slight, and even if it did

happen, the granule undoubtedly would be avoided. On the other hand, granules the size of a copepod are more frequent, and will be absorbed.

Finally, the noxious effect of the hydrocarbons is perhaps greater on the eggs and larvae stages than on the adults. As a matter of fact, it seems that the number of eggs and larvae of the Sardinella caught during these voyages is very low compared to the counts in other areas (the abundance was not known in the Ivory Coast prior to 1969).

Conclusion

There are two facts to be faced. On the one hand there is the catastrophic scarcity of coastal pelagic fish, particularly the Sardinella, that has lasted for over a year now. On the other there is the increasing presence of hydrocarbon residues deposited on the beaches and brought up in the plankton nets. It is apparent to us that there is bound to be a cause and effect relationship at work. Despite the fact that this still is a hypothesis, the presence of hydrocarbons in the stomachs of the Sardinella is the first element that permits us to back it up.

The research will continue along these lines, but here and now it seems to us indispensible that vigorous action must be undertaken at the international level to put an immediate stop to this deplorable practice of cleaning tanker tanks at sea in flagrant violation of the campaigns against pollution mounted by many countries.

There are appropriate solutions to the problem of cleaning the tankers, but until such time as they are put into practice by the oil companies, it would be hoped that at the very least they would respect the international rules that prohibit cleaning within 100 miles of coasts.

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